Climate Mean, Variability and Dominant Patterns of the Northern Hemisphere Wintertime Mean Atmospheric Circulation in the NCEP CFSv2

Peitao Peng, Arun Kumar and Bhaskar Jha

Climate prediction Center, NECP/NOAA

Outlines

1. Model bias in climate mean circulation and connection to the bias in tropical heating
2. Model bias in interannual variability
3. Dominant modes of atmospheric circulation
4. Predictability of the modes

Data

- DJF mean of Z200, U200, Prate and SST
- **OBS**: NCEP-NCAR reanalysis (1949-2011), CMAP precipitation (1979-2011), ERSST.v3(1949-2011)
- **CFSv2**:

  1. CMIP-type run (2001-2101) forced with increasing CO_2 forcing (2ppm/year) (Saha et al. 2013);

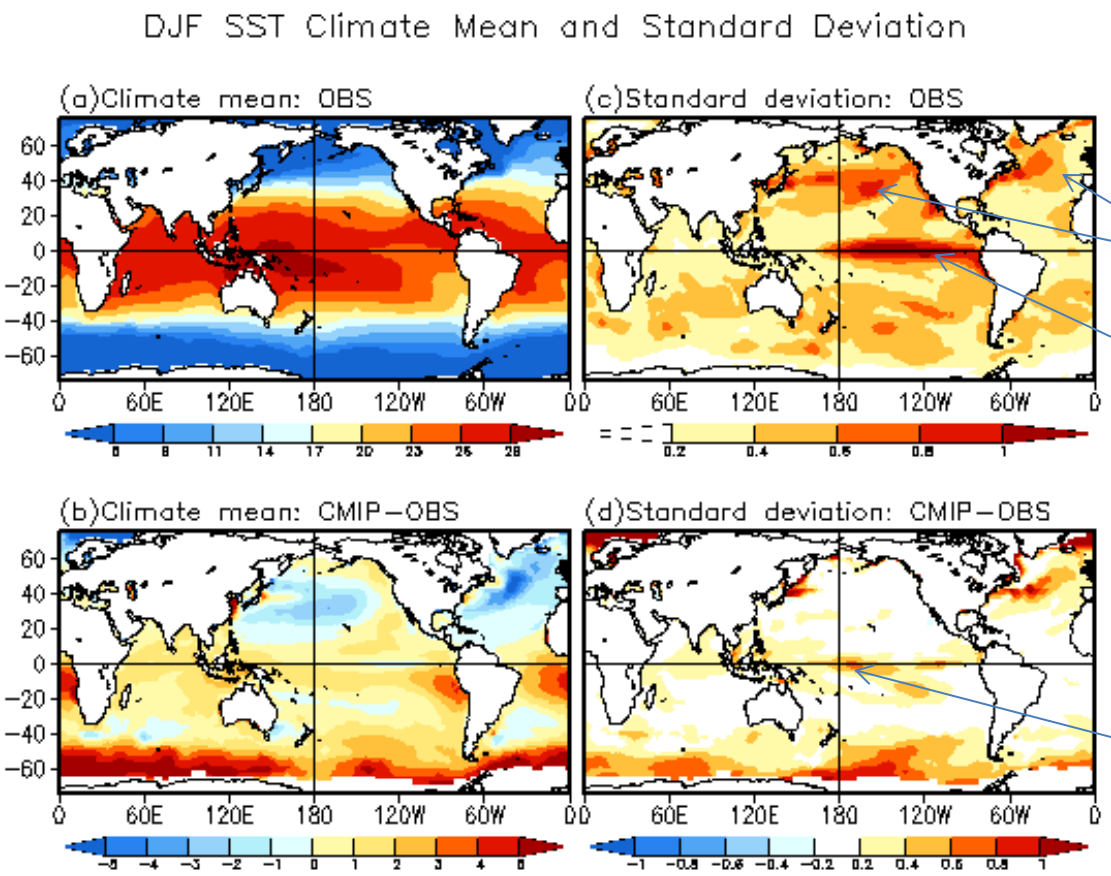
  2. AMIP-type run (1950-2010), 12 members

  All the data are linearly detrended

Analysis Procedure

1. SST examination for CMIP-type run
2. Bias in model stationary waves and the Prate
3. Interannual variability
4. ENSO teleconnection mode
5. REOF modes of the Z200 residual (with ENSO teleconnection pattern removed)
6. Predictability check for the REOF modes

DJF SST: CMIP-type vs OBS



Atmosphere forced

ENSO related

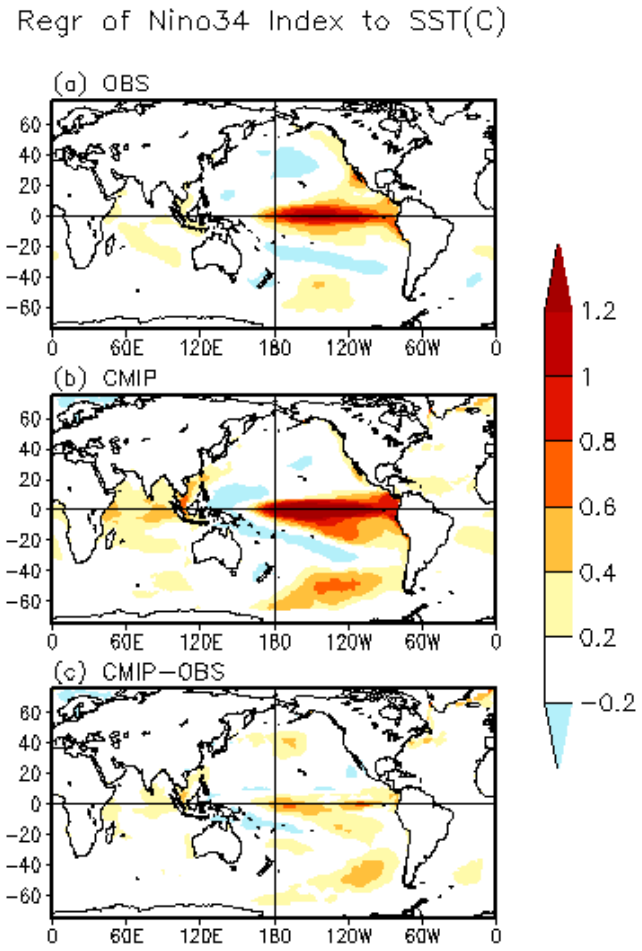
Stronger ENSO in model

Off coast warming is likely due to the model errors in marine stratus clouds;

Warming in tropical and southern oceans may be attributed to the increasing CO_2;

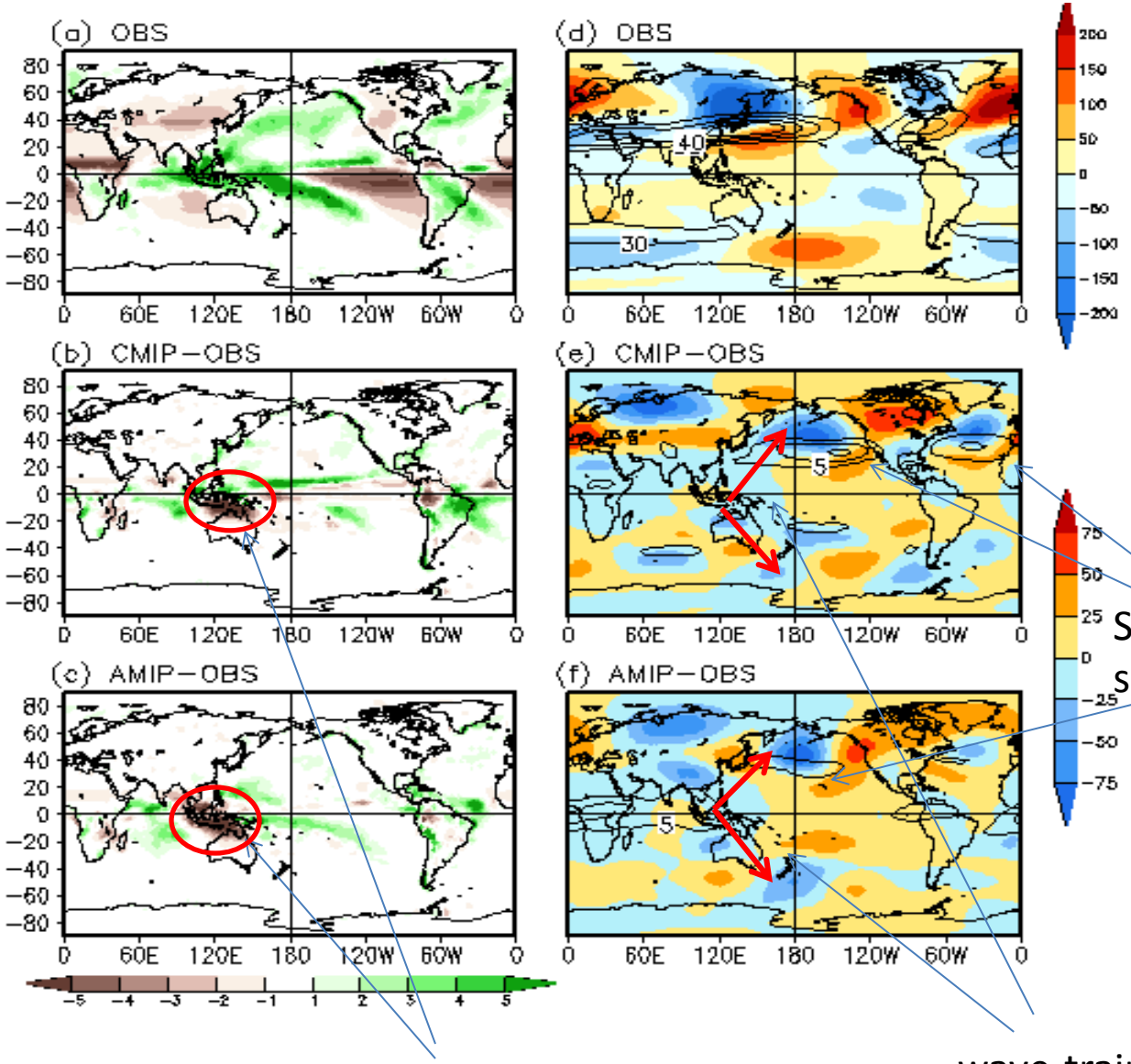
Cooling in northern oceans is likely due to Stronger surface winds through Ekman transport

ENSO Pattern of SSTs



ENSO signal is stronger in the model, and occurrence is more regular than in OBS (Saha et al 2013)

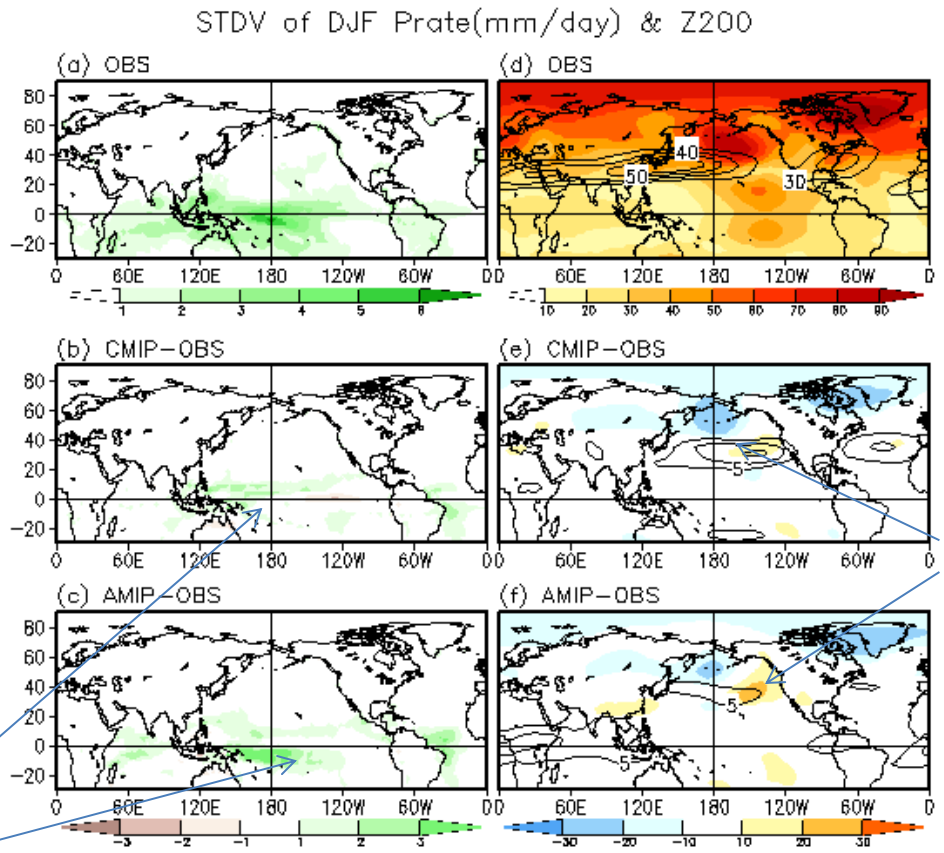
Model Bias in Zonally Asymmetric Prate and Eddy Z200



Stronger and southeastward shifted jets in model

Strong latent heat deficit → wave-train-like stationary wave bias (Peng 1995; DeWeaver and Nigam 2004)

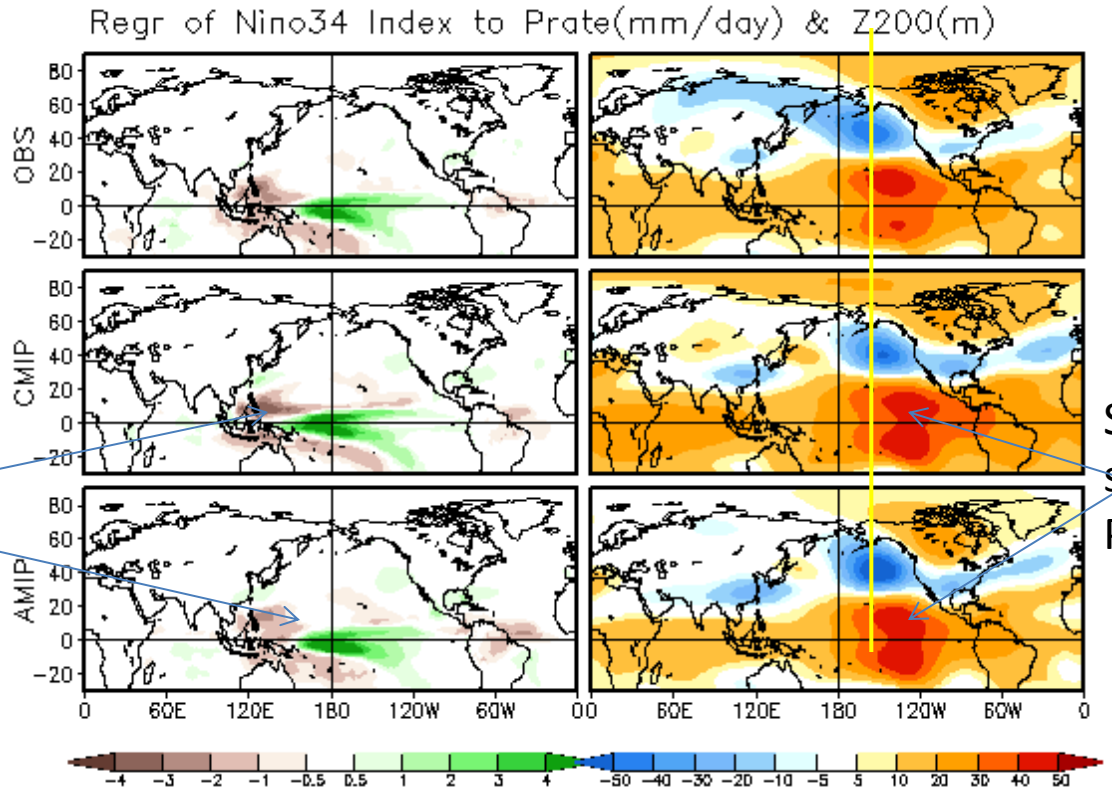
Inter-annual Variability of Prate and Z200



The southeastward shifted action centers over North Pacific may be guided by the shifted jet

Both simulations have stronger variability than OBS; the stronger variability in AMIP run is likely due to the lack of negative precipitation-SST feed back

ENSO Patterns of Prate and Z200

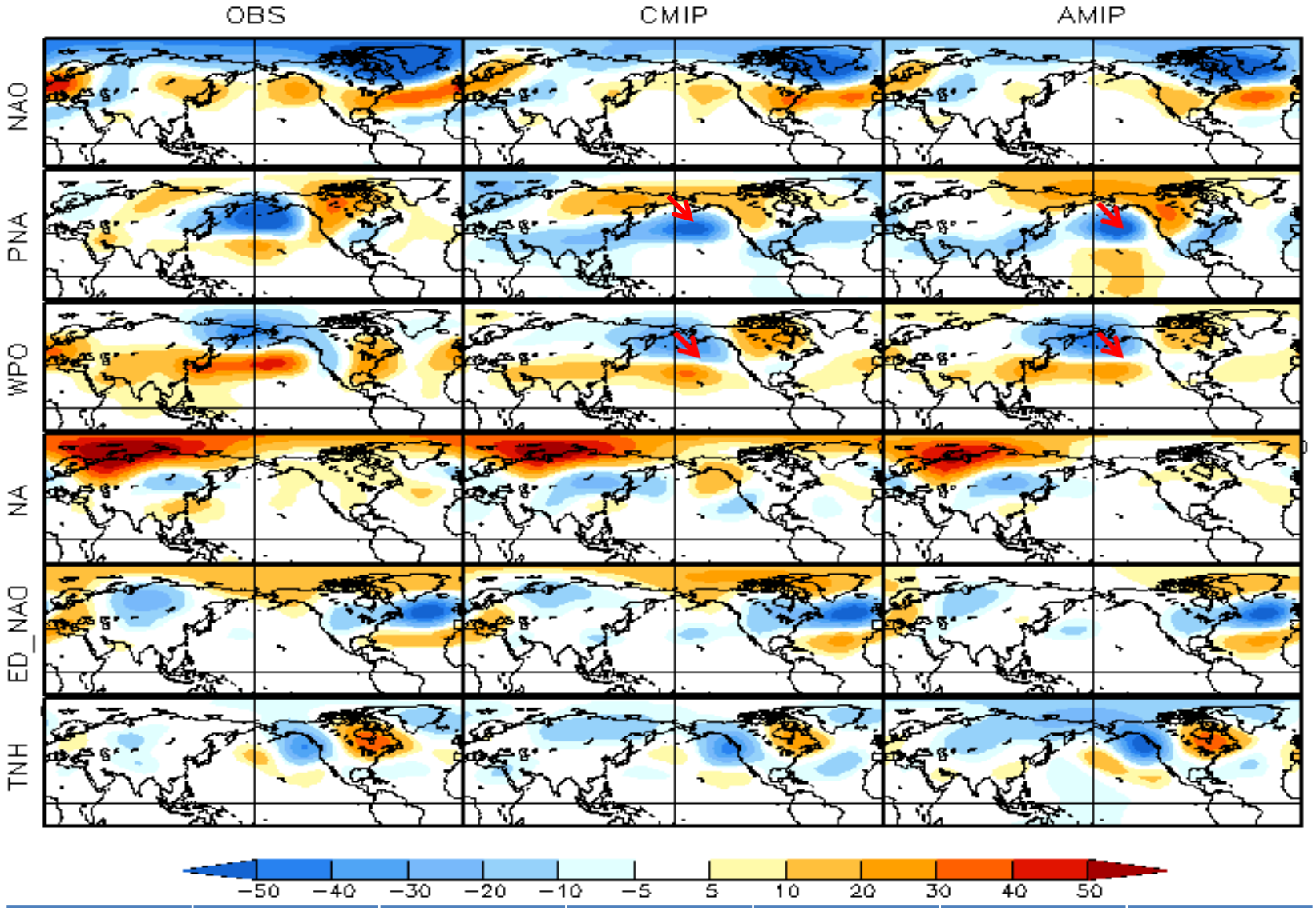


Stronger Prate
In the model

Stronger and eastward shifted atmospheric Patterns

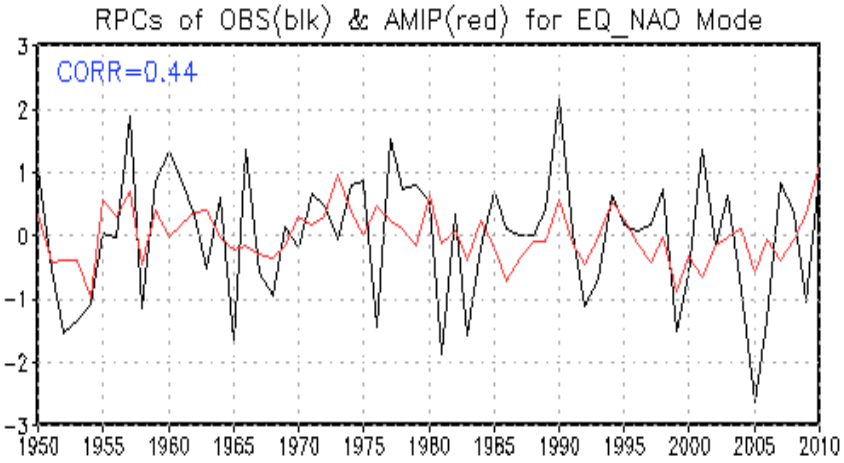
1. The stronger ENSO related Prate may be responsible for stronger atmospheric patterns
2. The eastward shifted atmospheric patterns may be due to the eastward shifted Pacific jet

REOF Modes of Z200 Residual

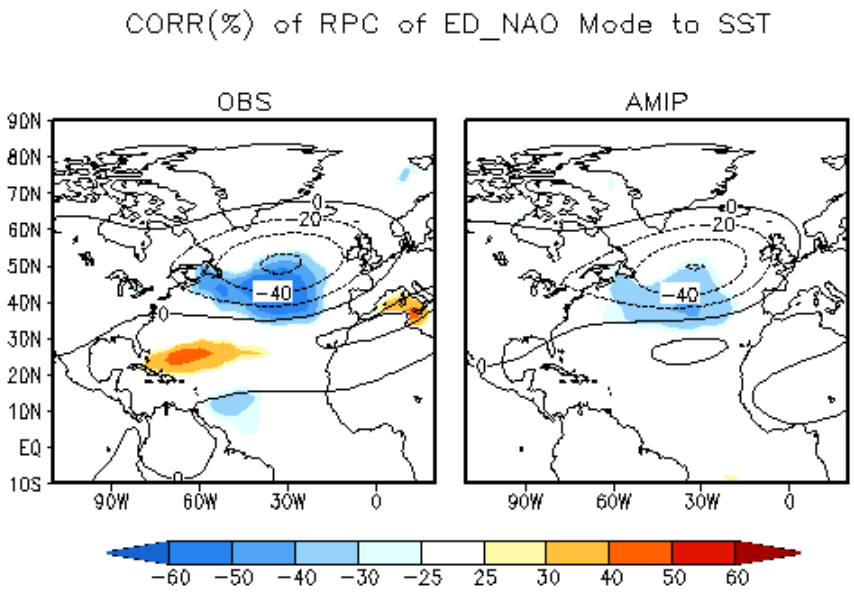


	NAO	PNA	WPO	NA	EQ_NAO	TNH
OBS	1st (22.7%)	2nd (12.0%)	3rd (10.8%)	4th (8.3%)	5th (7.6%),	9th (4.2%)
CMIP	1st (13.7%) COR=0.93	2nd (12.2%) COR=0.42	5th (7.5%) COR=0.49	4th (8.5%) COR=0.86	3rd (9.6%) COR=0.90	7th (5.2%) COR=0.81
AMIP	2nd (11.7%) COR=0.84	1st (12.3%) COR=0.46	4th (7.9)% COR=0.69	6th (6.3%) COR=0.88	5th (6.9%) COR=0.84	3rd (9.1%) COR=0.86

Are the REOF modes predictable?



Only RPCs of ED_NAO between OBS and AMIP are significantly correlated.

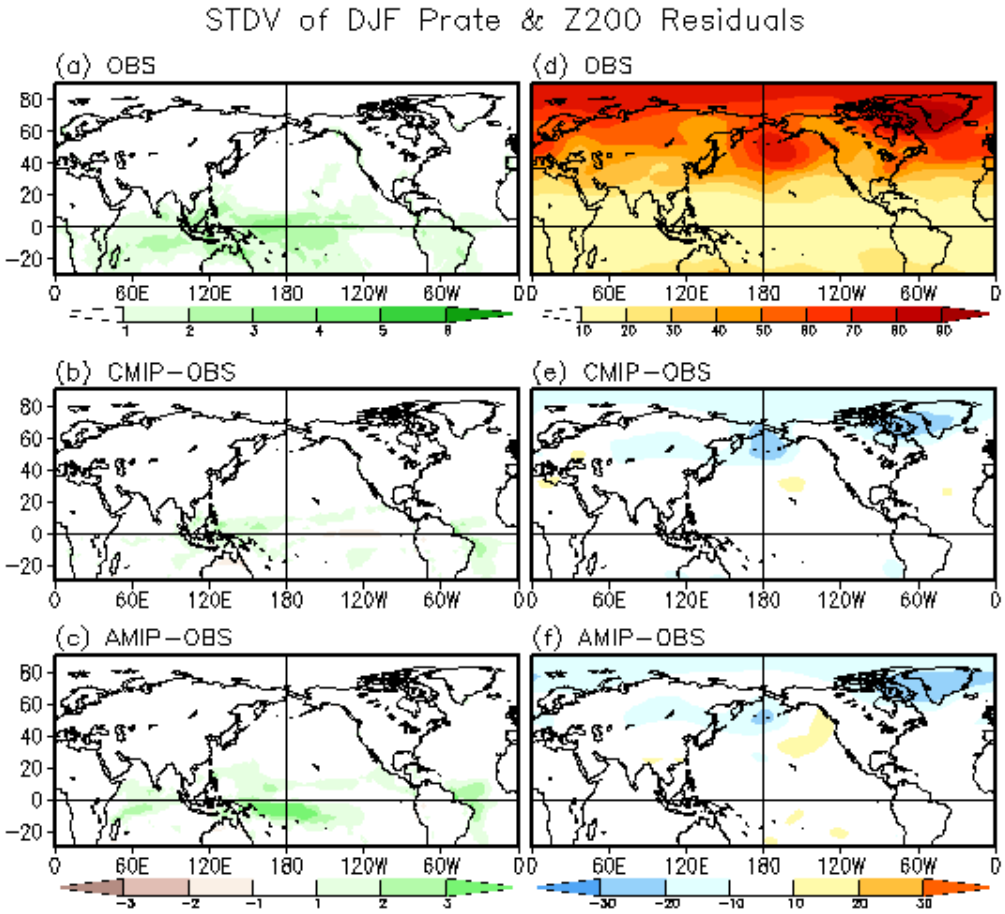


Similar SST correlation patterns of ED_NAO In OBS and AMIP run suggest the significant SST feedback to atmosphere→ longer predictability of the mode

Summary

1. Latent heat deficit over the Maritime continent → southeastward shift of the Pacific jet → eastward shift of ENSO teleconnection pattern and southeastward shift of PNA and WPO patterns. This finding has implication for model improvement.
2. Significant SST feedback exists only for ED_NAO mode, suggesting the potentially longer predictability of the mode (model dependent?)

Inter-Annual Variability of Residuals (ENSO signal removed)



Major differences in Z200 are in subtropical and North Pacific, and model biases are weaker there